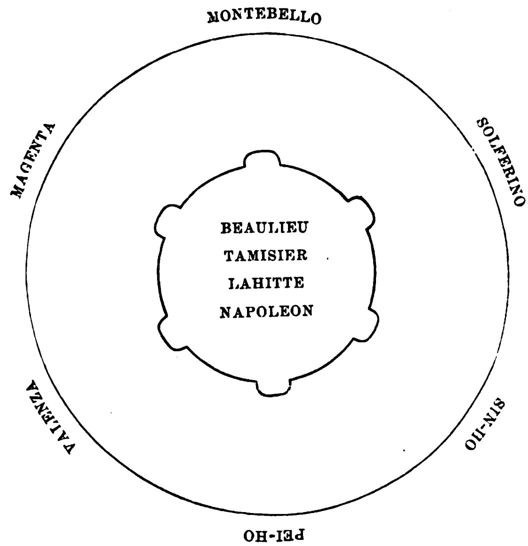
MONTEBELLO
SOLFERINO
SIN-HO
PEI-HO
VALENZA
MAGENTA
BEAULIEU
TAMISIER
LAHITTE
NAPOLEON

RIFLED FIELD PIECES.

A SHORT

COMPILATION OF WHAT IS KNOWN

OF THE

NEW FIELD ARTILLERY OF EUROPE,

WITH

SOME ACCOUNT OF OUR OWN.

"THE most philosophical method of determining beforehand what improvements an art or a science will undergo within a given time, is to study with care its past history, and to separate with discernment the principles which have triumphed from those which have failed, for the road of progress thus marked out in the past, indicates its own direction in the future."—(*Nouveau système d'artillerie de campagne de Louis-Napoléon Bonaparte.*)

WASHINGTON:
FRANCK TAYLOR.
1862.

PREFACE.

As great changes have been made in the field artillery of Europe within the last three years, the details of which are not to be found in any of the military text-books, it was thought that it might be useful to collect and publish such of them as can be most readily ascertained.

The following pages were accordingly prepared for the purpose of giving an outline of systems upon which we must to some extent model our own, and which have been themselves modelled upon the results of elaborate practical investigations in schools of artillery, and of instructive, although brief, experiences in actual warfare.

As far as practicable I have given my authorities for the various statements made, and where I have been compelled to draw inferences, in default of positive information, I have intimated as much, leaving it for the reader to make a more complete investigation for himself.

The works to which I most frequently refer are the following:—

LES CANONS RAYÉS Étude Militaire. par J. Schmœlzl. Lt-Col. d'artillerie. Traduit de L'Allemand. par E. Heydt, Sous-Lt. d'artillerie. Paris. 1860.

APPENDICE AUX CANONS RAYÉS. par Col. Schmœlzl. Paris. 1860.

LE CANON RAYÉ PRUSSIEN—Comparison des Systèmes Français et Prussien —par Capt. F. Fourcault. Paris. 1861.

LE CANON PRUSSIEN JUGÉ, par Les Allemands. Paris. 1861.

JOURNAL DES ARMES SPÉCIALES. 1860 & 1861.

I have drawn but little from English authorities, for this, among other reasons, that what they state is already more or less familiar to all those in this country who have taken an interest in the subject of rifled cannon.

RIFLED FIELD PIECES.

RIFLED field pieces are now in use in all European services, including that of Turkey, and, according to the statements of recent military writers, have, in France, totally displaced the smooth-bored cannon.[a]

The European rifled field artillery may be divided into two general classes, viz., the breech-loading cannon—including the Armstrong gun in England, and the Wahrendorff in Sweden and Germany—and the muzzle-loading cannon of Col. de Beaulieu, which has been adopted first by France, and shortly afterwards by Russia, Spain, Sardinia, Holland, Austria, and several other powers.[b]

The projectiles for the Armstrong and Wahrendorff guns are of cast iron coated with lead, and, being forced into the bore from behind, the lead enters and fills the grooves. For the Beaulieu gun, or, as it is sometimes termed, the French rifled cannon, the projectile has affixed to it, by means of small cavities made in the cast iron, knobs or buttons (*tenons-ailettes*) of zinc, which, in loading, are made to enter the deep and narrow grooves with which the gun is rifled. The grooves are, in France and Russia at least, and probably elsewhere, 6

[a] Le Canon Prussien Jugé, p. 15; Appendice aux Canons Rayés, p. 6.

[b] Le Canon Rayé Prussien, p. 79, and Les Canons Rayés.

in number, and the knobs 12,[c] although 6 knobs have been also used, so that only 1 knob should enter each groove.[d]

The Armstrong field gun is a cannon of considerable length and of narrow calibre (diameter of bore); 3 inches according to Capt. Benton ("Ordnance and Gunnery"), 74 millimetres (or 2.91 inches) according to Capt. Fourcault, of the Belgian army.[e] The denomination of the gun, taken from the weight of its projectile, is that of a 12-pdr., but a number of 6-pdr. guns have been recently made, 49 of them having been finished and proved up to November, 1861.[f] These latter pieces are possibly similar to the guns with which Sir William Armstrong made his earlier experiments, which had a calibre of 2 inches, a weight of about 500 lbs., and weight of projectile of 5 lbs.[g]

The weight of the Armstrong 12 pdr. is, for most of the guns, between 850 and 900, but 12 pdrs. of 6 cwt. have also been made.[h] The projectile, in order that it may have a sufficient shell power, notwithstanding its bolt like figure, is made up of a number of pieces of cast iron soldered together.

The Continental Powers, even those which have imitated England by adopting the breech loading system, employ larger calibres (the calibres of their field guns lying between 3.4 and 3.8 inches as far as they are known) and, in the case of France and Russia at least, lighter guns.

The calibre of the French rifled field gun has been variously

[c] Les Canons Rayés, p. 50; Journal des Armes Spéciales, July and Aug. 1860, p. 55, and Mars and Avril, 1861, pp. 237 and 242.

[d] Les Canons Rayés, pp. 50, 55, and 122.

[e] Le Canon Rayé Prussien, p. 43 (74 may, however, be a misprint for 76).

[f] Mechanics' Mag., Nov. 29, 1861.

[g] It is more probable, however, that the calibre of 3 inches would be retained and the weight put at about 400 lbs.

[h] Mech. Mag., Nov. 1860.

stated at 85.5[k] and 86.5[l] millimetres (3.366 and 3.405 inches), the latter being probably the correct calibre and the former the true diameter of the shot.

The weight of a French rifled cannon used in Italy is stated at 523 lbs. only,[m] but elsewhere 716 to 727 lbs. is given as the weight of the rifled gun of the Italian war,[n] and a good authority gives the present weight of the French field cannon at 727 lbs. (330 kilogrammes).† There are probably in the French service a lighter and a heavier rifled field piece, one a little over 500, and the other a little over 700 lbs. in weight, the heavier gun being the one most commonly in use, and the lighter being employed where great mobility is required.

Rifled batallion guns drawn by two horses each are said to have been issued to the French infantry;[o] these would probably be the lighter description of cannon.

The French have still another gun of the calibre of 3.4 inches, viz., their rifled mountain gun, which weighs 220 lbs. and is effective up to 1800 yards. This gun has been used in Kabylia, and is well spoken of.[p]

The weight of the projectiles for the above mentioned guns is about $8\frac{3}{4}$ lbs.,[q] but shells of over 12 lbs. weight seem also to have been used in Italy.[r]

The charge of powder is about $\frac{1}{7}$ of the weight of the pro-

[k] Les Canons Rayés, p. 52.

[l] Jour. des Armes Sp., Juil. and Août, 1860, p. 55. (It may be that the calibre of the gun was 85.5 mm. during the Italian war and has since been increased to 86.5).

[m] Les Canons Rayés, p. 54. [n] Appéndice aux Canons Rayés, p. 5.

† Col. d'Herbelot, Jour. des Armes, Ju. 1860, p. 55.

[o] Les Canons Rayés, p. 64. [p] Ibid., p. 53.

[q] When loaded, Jour. des Armes, Ju. 1860, p. 55.

[r] The account, however, seems rather to mean that a solid shot of the same size would weigh 12 lbs.

jectile for the heavier gun,[s] and the shell is stated to contain .44 lbs. of powder.[t]

The grooves in these guns are about 5 mm. deep and 16 mm. broad, and the twist one turn in two or two and a half metres.[u]

Rifled cannon of the 12 pdr. calibre (121 mm.) are also used in the French service. The rifled gun of reserve corresponds to the *canon-obusier* of 1370 lbs. rifled,[v] and the heavy 12 pdrs. rifled have been fixed upon as the guns of siege and position.[w]

According to a passage in a pamphlet by Col. Schmœlzl, the batteries of the Imperial Guard were armed with the rifled 12 pdrs. during the Italian campaign[x] of 1859.

In Austria, after the experience of the Italian war, and after having experimented with a French rifled gun captured at Magenta as well as with other rifled cannon, it was decided to adopt a gun of the 6 pdr. calibre rifled on the Beaulieu plan for a projectile with zinc knobs.[y]

This gun the Austrians speak of as having very satisfactory range and accuracy, and superior effectiveness.

The manufacture of the Wahrendorff gun, which had previously been commenced in Austria, was still carried on, chiefly, it is believed, for the armament of forts. More recently a rifle gun to be used with gun cotton has been introduced in Austria and has met with great favor.[z] The inventor of it is General

[s] Jour. des Armes, Ju. 1860, p. 55. App. aux Canons Ray., p. 5.

[t] App. aux Canons Ray., p. 5.

[u] Les Can. Ray., p. 113. Jour. des Armes, Mars, 1861. The lighter field pieces would probably have the quicker twist and the mountain gun a twist more rapid still.

[v] J. des Armes, Ju. 1860, p. 55. [w] Les Can. Ray., pp. 56 and 73.

[x] Les Can. Ray., p. 56 (Napoleon 12 pdrs. rifled).

[y] Le Canon Prus. Jugé, p. 19.

[z] Le Can. Prus. Jugé, p. 23. Gun cotton for smooth-bored cannon has been used in Austria since 1854. The gun used with it was of 12 pdr. calibre, 8

Van Lenk, and I do not know that the details of it have been made public. It may be remarked here, however, that the objections that have been made to the use of gun cotton in artillery are probably susceptible of being overcome much more easily than is generally imagined.

Russia was, apparently, one of the first nations after France to take up the Beaulieu gun, and seems to have been less reticent in making her experiments public than any other Continental power. An account of her field piece and of the results of practice with it have been translated from the Russian by Col. Neumann, and an abstract of this by Lt. Col. Schmœlzl is to be found in the Journal des Armes Spéciales, for March and April, 1861.

From this we learn the following among other facts:—The Russian gun is very similar to the French. Its calibre is 3.42 inches; larger than the French by about the amount of its windage. The weight of the gun is 650 lbs. (18 poods), that of the projectile 9.6 lbs., and that of the charge of powder 1.36 lbs. (1.5 lbs. Rus.), or about $\frac{1}{7}$ of the weight of the projectile. The grooves, six in number, have a depth of .17 inch and a twist of one turn in 11 ft. 4 in.

Its projectile has, like the French, 12 zinc knobs, which fit the grooves loosely; but the peculiarity of the Russian projectile consists in this, that it has, encircling its cylindrical portion, three grooves or cannelures similar in shape to those which are used on small arm bullets, and about $\frac{1}{4}$ inch deep. These must increase its accuracy, but diminish its range considerably.

Tables of direct firing with charges of one-seventh the weight of the shell give the following results; the comparative practice

calibres long, and provided with a cylindrical chamber in which the cartridge of compressed gun cotton was placed. J. des Armes, Ju. 1860, p. 5.

upon for this sort of firing are those of 24, of 30, and of 36 solotniks (1 lb. av. = 107 solotniks nearly), and the ranges attained with the last named charge go up to 1300 yards.

Used in this way, the gun is made to serve the purpose of a rifled field mortar, and, when fired at these high angles, at a square space, each of whose sides was 15 sagènes (= 35 yds.), it gave the following results, which are compared with those attained at the same time with a Russian howitzer of slightly greater weight:—

Distances in sagènes.	Per cent. of hits with rifled gun.	With a 12 pdr. howitzer.
350	39	14
400	38	10
450	34	7
500	29	
550	25	
575	23	

When fired with the full charge of ¼, the velocity of the projectile, at 88 feet from the gun, was 1,175 ft. per second, and the number of rotations 103 to 104 per second.

The windage of the projectile is from two to four hundredths of an inch, and it will hold about .36 lb. av. of powder.

In the year 1859 Prussia, like most other European nations, began to occupy herself energetically with the subject of rifled guns, and during that and the subsequent year introduced a large number of them into her field artillery.[a]

The Prussian rifled field gun is a breech-loader, of cast steel, and of the calibre of a 6 pdr.,[b] or of 91 millimetres[c] (3.58 inches).

The breech-loading mechanism is a modification of that of Wahrendorff, but its precise details, as well as some other points concerning the gun and its projectiles, are considered as secrets.

[a] Les Can. Ray., p. 77. App. aux Can. Ray., p. 12.

[b] Les Can. Ray., p. 77.

[c] Le Can. Ray. Prus., p. 45.

The weight of the projectile is stated to be 10 lbs. Prussian[d] (10.3 lbs. av.), and the weight of the charge $\frac{1}{10}$ to $\frac{1}{12}$ that of the projectile.[e]

Shrapnels are fired with concussion fuses of secret construction, the shell being made to burst by striking the ground in front of the mark. A time fuse, however, also seems to be in use.[f]

In Belgium, experiments with rifled cannon have been carried on at Brasschaet since 1856.[g] In 1860 the adoption of the Beaulieu gun was decided upon, and some rifled guns were made of 6 pdr. calibre[h] (95 mm. or 3.74 inches). In the same year, however, a Belgian officer—who had attended the famous Prussian experiments at Juliers, of September, 1860, when the ancient fortifications of that town were regularly besieged, and battered with the new breech-loading rifled artillery—brought so favorable an account of the Prussian gun,—which it appears that Belgium, as an ally of the German Confederation, was allowed to learn the secrets of,—that the Belgian minister of war ordered it to be adopted;[j] and in January, 1861, an appropriation of 14 millions of francs was asked for from the Belgian Parliament for the purpose of introducing the Prussian system.

This, however, did not pass without protest from the advocates of the muzzle-loading system, who allege, and apparently with reason, that the proposed change is capricious and bureaucratic, and not supported by the opinions of the best informed artillery officers.[k]

In Holland the French system has been adopted.[l] The mode in which they have transformed their artillery is peculiar and

[d] Les Can. Ray., p. 79.
[e] Le Can. Ray. Prus., p. 63.
[f] Ibid., pp. 69, 70.
[g] Les Can. Ray., pp. 58, 59.
[h] Le Can. Ray. Prus., p. 21.
[j] Le Can. Prus., p. 20.
[k] Le Can. Prus.
[l] Ibid., pp. 49, 77.

deserves mention. Old bronze guns, many of them defective or worn-out, have been filled up with melted gun-metal, and re-bored and rifled, making a field gun of about the same calibre as the French, and at very small cost.

In Spain the old bronze guns of the 4, 12, and 24 pdr. calibres have been rifled on the French system.[m] Rifled guns were used in the war against Morocco.[n]

In Portugal rifled guns of 4 pdr. calibre, and on a Portuguese plan, whose details are not specified, have been introduced. They are distinguished for a low trajectory, having with 1° elevation, a range of 750 metres,[o] and they have, it would appear, considerable accuracy.

In Italy, the Cavalli breech-loading gun has been much used for heavier artillery. It has also been tried for field guns, but abandoned for the Beaulieu gun.[p] At the siege of Gaetà the Cavalli siege guns are said not to have answered so well as the muzzle-loading rifled guns,[q] the breech mechanism having in several cases given way in the trenches.

Beside the above mentioned powers, Switzerland, and, among Mohammedan nations, Tunis and Egypt are mentioned as having adopted the French system of rifled field artillery.[q]

While the Beaulieu gun is the one most generally used for field and siege artillery, the use of breech-loading rifled guns for ships and casemates seems to be universal,[r] and their superior fitness for these positions is conceded, even by a controversial advocate of the muzzle-loading field artillery.[s]

France herself, who stands in the foremost rank as a champion of muzzle loading for the guns of field batteries and of

[m] Les Can. Ray., p. 78.
[n] Le Can. Ray. Prus., p. 78.
[o] Les Can. Ray., p. 79.
[p] Le Can. Ray. Prus., pp. 48, 78.
[q] Ibid., p. 78.
[s] Canon Prus. Jugé, p. 15.

siege trains, employs breech loaders for ships and sea coast batteries.[t]

It is worthy of notice that even for breech-loading cannon[u] the French employ the Beaulieu projectile, or, as they express it, the projectile *artificially forced*, and not the lead coated, *naturally forced* projectile of the Armstrong and Wahrendorff guns. It may be, however, that, although the shell itself preserves a windage in the bore, the zinc knobs are more or less forced in passing through the grooves, so as to hold the projectile more steadily.

The French breech-loading cannon is said to be of the simplest construction,[v] and, from what account has been given of it, would seem to be some modified form of what has been known in Europe as the American breech-loading cannon.

However well satisfied the powers of Europe may have been with their breech-loading guns for ships and casemates, it is doubtful whether the necessity of firing rifled guns with heavy charges of powder, to enable them to pierce the sides of iron clad vessels, will not induce the readoption of muzzle loaders.

MM. Petin and Gaudet, proprietors of a patented method for circling old cast iron guns with steel or iron rings, preparatory to rifling them, are said to be engaged in thus strengthening 700 guns for the French government.[w]

These guns can hardly be meant for conversion into breech-loaders.

In considering the good qualities of the new system of field artillery, European writers lay particular stress upon its mobility.

The rifle system, it is said, enables guns to be used which are

[t] Can. Prus. Jugé, p. 16.
[u] Ibid., Can. Ray. Prus., p. 50.
[v] Canon Ray. Prus., p. 50.
[w] Can. Ray. Prus., p. 87.

lighter than any *efficient* smooth-bored cannon.[x'] Such guns can be brought up, over the worst roads, and the steepest hills, and be used where other artillery would not come into action in time.[x'] They can change their positions so frequently as to evade the efforts of a heavier hostile artillery to silence them, and still be able by reason of their long range to fire with effect on the enemy's troops.[y']

They can follow closely a retreating enemy, and keep him under a fire of shells, as was done at Magenta.[z']

At the same time the guns require fewer horses than heavier artillery would, four horses being allowed to the French and Russian guns of 3.4 calibre.[a'']

In the Italian war the mobility of the French artillery is said to have been a main element of success, and especially at the battles of Magenta and Montebello.[b''] In the Chinese campaign, their lightness is said to have given them a decided advantage over the Armstrong guns.

The principle has been laid down and apparently acted upon, that great mobility of material is most important to those nations that expect to undertake offensive war, and especially maritime expeditions; while nations that intend to carry on defensive wars only, and that in an open country and over good roads, should aim at having heavy guns of long range and great accuracy.

As far as it can be known, it would appear, that in the new artillery system of Europe, the general rule prevails, that the more powerful a state is in relation to its neighbors, the lighter are its field pieces.

When the introduction of rifled cannon was first proposed

[x'] Les Can. Rayés, p. 67.
[y'] Ibid., p. 71.
[z'] App. aux Can. Ray., p. 11.
[a''] Les Can. Ray., p. 64.
[b''] Ibid., p. 64.

many persons, speaking *a priori*, and from traditions of former artillery service, were disposed to underrate the importance of their long range firing, which, it was said, could never produce these decisive effects on troops, which are the chief objects of artillery fire. It was found, however, in the campaign of '59 that although shelling at distances of 2, 3, and 4,000 yards cannot overthrow and put to flight infantry in line of battle, yet it can force an enemy to deploy his columns at inconvenient distances, embarrass his distant movements,[c''] prevent his reserves from occupying advantageous positions, destroy the men and horses of his batteries, and thus influence the fate of the battle as decisively, although not as brilliantly, as the "*charge of artillery*" at Wagram.

The power which long range artillery has of concentrating its fire from a number of distant batteries was important to the French in checking sudden attacks on weak points of their line. At Solferino, the coming into action of a large body of Austrian cavalry was completely prevented by this means.[d'']

Accounts have been made public of the results of practice at long range, of the French rifle guns of 3.4 calibre at the camp of Chalons.[e''] The mark fired at was an inclosed space of 50 × 75 metres, representing the space occupied by a battalion formed in column of divisions, at platoon distance, and the ranges varied from 1800 to 3000 metres. (1 metre is equal to very nearly one and a tenth yards.)

With the rifled gun which was used in the Chinese campaign, firing at distances of from 1800 to 2500 metres, out of every 150 shells, 110 to 120 struck in the rectangle. At 1800

[c''] At Médole the French rifled guns took up a position from which they commanded, at long range, the roads by which the Austrian artillery attempted to approach. (Les Can. Ray., p. 70.)

[d''] Les Can. Ray., p. 66.

[e''] Can. Ray. Prus., pp. 66 & 67. Jour. des Armes, Nov. 1860.

m. the projectile ricocheted for some distance. At 2500 metres it buried itself. At 3000 metres, 100 out of 150 projectiles struck within the mark.

The mounted gun of 100 kilogrammes (or 220 lbs.) gave similar results at 1800 metres.

These results are in accordance with those said to have been attained in Russia and Holland with guns of the same calibre; and in Belgium, with Beaulieu guns of the 6 pdr. calibre, better firing still has been made, according to Captain Fourcault.

In the Italian war the remarkable effects of the rifled cannon were mainly produced at long ranges, but their use was not confined to distant firing, for in the attack on the Austrian centre at Solferino, the rifled cannon of the Imperial Guard were brought up to within 300 metres of the hostile line, and by their fire decided the French success on that point.[r''] It would seem, however, from what has been previously stated, that these batteries of the Guard consisted of the rifled canon-obusiers of 12 pdr. calibre. Whether, at these close quarters, the rifled guns fired canister shot, or rifle shrapnel with very short fuzes, is not stated, but it has been proposed in Europe to substitute these latter projectiles for canister altogether, thus simplifying the ammunition.[s'']

As a question may be raised on the propriety of the French course in rifling their canon-obusier, it may be worth while to make some remarks upon the effect of an elongated projectile on the gun and its carriage. The canon-obusier or light 12

[r''] Les. Can. Ray., p. 72.

[s''] The rifle system is said to be peculiarly favorable to the use of shrapnel, for the projectile, instead of the irregular and variable rotation which spherical shells acquire, has a uniform motion around its greater axis, and the cone of dispersion of its contents is consequently more uniform. (Les Can. Ray., p. 131.)

pdr. gun—smooth bore—throws a projectile weighing 12 lbs., with an initial velocity of about 1500 feet per second, which is communicated to it by a charge of $2\frac{1}{2}$ lbs. of powder. A projectile of 18 lbs., fired with a charge of a little over 2 lbs., would acquire a velocity of 1000 ft. per sec., and in doing so, would strain the gun carriage less by the recoil.[h''] At the distance of 800 yds. from the gun, the velocity of the rifle projectile would begin to surpass that of the spherical, and would rapidly gain on it at all greater ranges.

The French, like other nations of Europe, seem to be averse to publishing the details of their new artillery system, but as far as it can be made out from those works to which I have had access, and I am persuaded that they give correctly its most important features, it seems to be very simple and efficient, and to have been arranged with much military skill.

But two calibres are now used by the French for both field and siege artillery. In these are comprised five or six different guns, varying by a systematic gradation of mobility and power, from the cannon which can be carried on the back of a mule, to that which is deemed powerful enough for all siege purposes.

The lightest of these can shell fortifications with effect at the greatest distance of siege batteries, and the heaviest of them is

[h''] The *amount of motion* given to the two projectiles would be the same, but the slower moving elongated projectile would receive its motion during a longer period of time, and the resulting impulse of recoil would therefore be a slower one; less of a blow and more of a push. Beside this, the amount of powder fired with the elongated projectile is somewhat less, and consequently there is a less weight of products of combustion to be thrown from the gun.

In the new system of artillery of continental Europe the carriages are said to have been much lightened as well as the guns themselves, and the above considerations may help to show why such reduction of weight is practicable and unobjectionable.

not of a greater weight than it is customary to use on the field of battle.[///]

In any war in which they may be engaged, or in any expedition which they may fit out, they can, by varying the proportionate number of the different guns, adapt themselves to the circumstances of the case. The majority of their field batteries, however, are armed with the gun of 3.4 calibre and 727 lbs. weight; at least it may be so inferred from what is said of this gun, the lighter field gun being somewhat of an exceptional piece.

In the United States, the first decided movement toward the introduction of rifled cannon into service was contemporary with that made in almost all European countries, viz., in the year 1859. Previously to that, however, the subject had been agitated by the Ordnance Department, and the attention of artillerists and of inventors had been directed to the production of projectiles on the *expanding* system, a system which, although suggested by the success of the expanding bullets for small arms, has never been brought into use in Europe, but which in all probability may, if properly perfected, prove the most suitable of any for military use.

That it would prove so was the opinion of the Board on Rifled Ordnance of 1859, with one dissenting member, who recommended further trials, and a favorable consideration of, artificially forced or flanged projectiles.

It was contemplated to establish a permanent board to investigate the subject, whose labors should extend over a series of years, as has been done in European countries, but this course was baffled by the then Secretary of War, who opposed systematic experiments for the improvement of the artillery of the

[///] Excepting, perhaps, their heaviest siege guns, which are probably their old 12 pdrs. of siege rifled, and weigh over 1500 kilogrammes.

United States, and determined to impose upon it a projectile which had been known in Europe, under a very slightly different form, as the Charrin projectile,[k''] and which had been patented in this country by Ex-Senator James, of Rhode Island.

A board was appointed by the Secretary for the purpose of carrying out his views in this matter, which, during the latter part of 1860, made the desired recommendation in favor of the James projectile. An examination of the official record of this Board, however, disclosed facts irreconcilable with the opinions expressed, and this led to an opposition to its recommendation, which prevented the introduction of the projectile in question until after the commencement of the present war.

In the spring of 1861, however, influences were brought to bear which caused the James projectile to be extensively adopted, and it enjoyed a considerable amount of factitious reputation, until artillery officers of the regular and volunteer services began to make experiments with it in various parts of the country, when a strong and unanimous condemnation of it seems to have forced its withdrawal from service.

Other expanding projectiles have been used in our army, which it is not necessary to mention here, and whose merits, as compared with each other, have recently been made, to some extent, the subject of investigation. The experiments made by the Army, and those made by the Navy under the direction of Captain Dahlgren, leave no doubt of the fact that the American system of projectiles is capable of meeting the requirements of military service, although whether any particular projectile is, as yet, what it is desirable that it should be in regard to accuracy at long ranges and effectiveness as a shell, does not clearly appear.

The introduction of rifled cannon into our service has not been rendered, as it has been elsewhere, a means of simpli-

[k''] Les Can. Rayés, p. 41.

fying calibres. We have had made, during the present war, bronze rifled guns of the different calibres of 3.67 and 3.8 inches, and large numbers of iron rifled cannon of 2.9 and 3.0 inches; and having already both smooth bore and rifled guns of the calibre of 4.62, guns of 4.5 are now being also made. The narrow calibres of 2.9 and 3.0 inches are evidently imitated from the English, without knowledge or without regard of the fact, that the calibre of the Armstrong field-piece had been considered and rejected by all Continental nations, as sacrificing too much to the attainment of a needless length of range, and as not giving an efficient shell, except by the employment of a projectile which, as it is expressed, "is of itself a sort of *chef d'œuvre* of mechanical construction."[1]

There is another objection to these calibres. The projectiles for both of them could be fired from the Armstrong 3 inch gun, one of them at least with its best effect, while the breech-loading Armstrong shell would enter neither of them. In order that one of our shells should be useless if captured by the English, it should not only be larger than three inches, but considerably larger, since the turning off of a small quantity of metal from the cylindrical portion of a shell is quickly done, and the Armstrong artillery is accompanied in the field by a corps of trained mechanics, well equipped with tools, among which portable lathes would probably be included. This consideration is not, perhaps, of great present importance, since the use of the Armstrong calibre will not extend to any European nation beyond Great Britain, and if in the present war we meet with any rifled artillery of European plan or manufacture, it will be the cheap and efficient Beaulieu guns and projectiles, probably of the French weights and calibres.

[1] If we are to adopt the Armstrong calibre we ought also to adopt the built up projectile whose peculiar construction enables that calibre to throw an effective shell.

If we had retained the 6 and 12 pdr. calibres for our rifled guns, we would in so doing have been justified by the precedents of various European powers, who have organized their rifled artillery after witnessing the experience of their neighbors.[m''] The old 6 pdr. rifled would approach nearly, in the proportions of its calibre to the length of bore and the weight of metal, to the standard French field piece of 330 kgms., which it would somewhat surpass in range, and decidedly surpass in power, supposing an equally good projectile to be used.

The 6 pdr. calibre would not probably be too great for a rifled mountain gun, nor for a field gun whose weight should lie between that of the lighter French field piece and the Armstrong field piece of six cwt.

With the expanding system of projectiles less caution is necessary in not fixing the calibres too high, since there are various forms of these projectiles in which the shot can be made much smaller than the true calibre, the bore of the gun being filled up by a non-metallic packing or sabot.

By the introduction of light rifled guns with heavy projectiles, something is lost in the efficiency of trajectory for direct fire at short ranges.

The exact nature of this loss is shown in a table drawn up by Col. de St. Robert, of the Sardinian Artillery, the author of various treatises on the motion of projectiles. The two projectiles compared are of about the same weight, and, for the

[m''] It appears from an essay by the Count Paul de St. Robert, Col. of the Sardinian Artillery, that Sardinia adopts the 6 pdr. calibre for rifled field pieces. That both Austria and Sardinia should have done so after the experience of the Italian war, and after careful experiments with different guns, suggests what the real course of military progress is in this matter, and it may be further observed that Belgium, which has watched the experience of the French very closely indeed, also adopted, in 1860, the 6 pdr. calibre.

different ranges, what the French call the "*espace battu*"[n] for an object 2.50 metres high is given.

Rifled Cannon of 4 *with charge of* ⅛.

Distances in metres	300	500	750	1000	1500	2000	2500	3000
Espace battu in metres . . .	156	95	56	39	21	13	8	5.5
For 8 pdr. smooth bore, charge ⅛,	263	119	56	31	11	5	2	1

The guns compared are evidently the same with the French rifled field gun of 330 kilogrammes, and their old 8 pdr. of 580 kilogrammes, and it will be seen that leaving out of sight the question of accuracy, the heavy smooth bored gun has, up to the distance of 750 metres, the best trajectory.

It has been supposed that the trajectory of rifled cannon is to be rendered flatter, or as the French express it, more "*rasante*" by employing narrow calibres and long projectiles. Calculations and experiments, however, show that within the ordinary limits of weight and length of shell employed in rifled cannon, and within those distances at which flatness of trajectory is of importance, the shape of the trajectory, and the consequent "*espace battu*" is more affected by an increase of the initial velocity than by using a bolt-like projectile.

[n] The terms "Espace Battu" of the French, "Bestrichner Raum" of the Germans, and "Dangerous Space" of some English writers are used to signify that space or distance over which a bullet, in approaching the termination of its flight through the air, passes within a certain distance from the ground, that distance being the height of either an infantry or a cavalry soldier. If, for illustration, the Espace Battu for infantry at a certain distance be 50 yards, and a man is standing 60 yards in front of the place where the bullet strikes the ground, that bullet will pass just over his head. The efficiency of fire depends greatly upon the length of this *dangerous* or *enfiladed* space, especially where the distance cannot be correctly judged of, or where the aiming is not very accurate. This space is greater in proportion as the velocity of the projectile is greater.

In speaking of the calibres of rifled field pieces, it may be here remarked that the calibre of three and four-tenths inches was adopted by Capt. Dahlgren for rifled boat howitzers at about the same time at which it was introduced in France and Russia.

This is good independent evidence of a well-founded presumption in favor of that calibre, and as numbers of rifled boat howitzers are now being made for service with naval expeditions, the same bore could be adopted in our army with some show of reason.

We must, however, take into consideration the fact previously mentioned, that in Europe the most recent decisions have been in favor of a calibre for rifled guns about that of our six pounder or even a little larger, and this tendency to an increase in the calibres of rifled field pieces is the more noticeable since with rifled small arms the march of progress is in precisely the opposite direction.

The nice adjustments of calibres and weights of fire-arms are much studied among the military nations of Continental Europe, and the truth is recognized that correct judgment in these things, especially as regards artillery, has a preponderating influence on military efficiency. They are causes of success or defeat, small apparently for any one occasion, but which are continually operating, and in long struggles between well matched armies, victory is apt to rest ultimately with that power whose artillery excels in all matters of detail. To obtain superiority as concerns new improvements, either of two courses may be followed.

One is to bring into the field useful novelties before an antagonist has adopted them, as was done by the French with regard to rifled cannon in their campaign of 1859. To do this with effect requires promptitude and sagacity, and much care

and conscientiousness, in either adopting or rejecting proposed innovations.

The second course is to wait until some important improvement has made its way among other nations, and to observe in what direction it advances toward its most perfected form, and then to model our own material by imitating the most advanced and approved plans, or by taking from the various foreign systems whatever appears to be most excellent in each.

NOTES.

NOTE A, page 9.—In the recently published United States Ordnance Manual (p. 489) it is stated that the French rifled field piece has a calibre of 3.31 inches and a weight of 670 lbs. This is the calibre and the weight of the *smooth bored* 4 pdr. of the French army ("Gribeauval cannon of 4"), and as their rifled gun is frequently termed by them "the rifled cannon of 4," it has apparently been erroneously assumed to be identical with their old 4 pdr.

Several years ago the French began a course of experiments by firing with cannon of about the calibre of our 32 pdr. which had only two grooves. This number of grooves was found to be insufficient to keep the shot steady in its passage through the gun, and it was increased until it reached six. (Les Can. Rayés, pp. 49 and 50, Jour. des Armes, July, 1860.) In Belgium tolerably good results have been obtained with 4 grooves. (Les Can. Ray., p. 60.)

Capt. George Reichenbach, of the Bavarian Army, a distinguished mechanician and savan, made, in 1816, a small field piece, or rather a wall piece, with 7 grooves, whose projectile combined in itself the principles of the Minié bullet and of the present Beaulieu projectile. The influence of routinism, and the distaste for military innovation which had followed the exhausting wars of that period, caused this invention to be neglected.

NOTE B, p. 11.—The rate of twist for this rifled gun was determined by the Russians, by means of a method which appears ingenious, but somewhat liable to fallacy.

NOTE C, p. 12.—The military pace of 28 English inches is the foundation of the Russian system of measurement by Archines, Sagènes, and Versts. An Archine is the length of one pace, or 28 inches. 3 Archines = 1 Sagène. 500 Sagènes = 1 Verst. (3 Sagènes = 7 yards.)

NOTE D, p. 14.—It may be remarked, that the term rifled 4 pdrs., or rifled cannons of 4, is applied to those rifled guns whose calibre is not far from 3.40 inches; and the term, rifled six pounders, to those whose calibre is about 3.60, 3.70, or 3.80.

NOTE E, p. 17.—The penetrative force of a projectile being in proportion to the square of its velocity,* and its initial velocity being in proportion

* The statement that the penetrative effect of a projectile increases as the square of its velocity is not precisely correct, although sufficiently so for the present argument.

It would be more exact, in both a scientific and a practical point of view, to

to the square root of the ratio of the weight of the powder to that of the shot, its power of penetration, at short ranges, will be in direct proportion to the amount of powder used, other things being equal, and a certain proportion being kept between the amount of powder and the length and calibre of the gun.

To enable a gun to resist the bursting effects of heavy charges, the method mentioned in the text, of encircling the cast iron with wrought iron or with steel rings, and especially with the latter, seems well calculated to be successful. What the precise method used in France is, I do not know, but in England old guns have been circled by applying to them, behind their trunions, longitudinal bars so shaped as to convert that part of the gun into a cylinder, and then shrinking on over them wrought iron rings. This method is said to answer well, but a better one might, I think, be suggested.

For the purpose of penetrating iron plates, projectiles of a material less easily broken than cast iron seem to be desirable; wrought iron, puddled steel, or hard bronze may be considered as suitable for this purpose. With projectiles of the same shape and material the penetrative power increases as the diameter, while the weights increase as the cubes of the diameters. Thus a 20-inch round shot would penetrate only twice as far as a 10-inch ball moving with the same velocity, although its weight would be 8 times as great. If the velocity of the 10-inch ball was four-tenths greater than that of the 20-inch, then their penetrations would be about equal.

The crushing effect or momentum of very heavy shot has been supposed to render them peculiarly suitable for breaking through the sides of iron-plated vessels, but shot weighing 200 lbs. fired at a target covered with the plates used for the Black Warrior frigate, did not produce much effect, even when fired in volleys.

The real power of artillery does not lie in the *momentum* of its projectiles, but in what philosophers call their *living force*. A shot weighing half a ton, moving at the rate of one thousand feet a second—a velocity which it would require more than a hundred pounds of powder to communicate to it—would have a momentum equal to that of fifty tons moving at the rate of ten feet per second, or at about seven miles an hour.

A vessel of fifty tons weight, which should sail against the Black Warrior frigate at the rate of seven miles an hour, would hardly be able to break a hole in her side by striking against her, even if the yacht were armed with an iron-shod prow.

say that the power of penetration increased with the square of the velocity, an allowance being made for certain effects of the projectile which are aside from its actual work of breaking through the resisting medium.

The amount of this allowance, or rather the rate of its increase with the velocity of the projectile, is to be determined by actual experiment in those cases where it has a sensible magnitude.

NOTE F, p. 23.—Some remarks on the record of the Board in the case of the James projectile are to be found in Executive Document No. 43, of the 36th Congress, 2d Session, House of Representatives.

NOTE G, p. 25.—If two guns be in exact proportion to each other, their weights, the weights of their projectiles, and the weights of their charges of powder, will be in the ratio of the cubes of their respective calibres. Taking the French gun of 727 lbs. weight as a starting point, we have for a rifled gun of 3.67 calibre, 920 lbs. for the weight of the gun, between 10.5 and 11 lbs. for that of the projectile, and 1.5 lbs. for the charge of powder. Our present six pounder weighs 880 lbs., and therefore, if rifled with its present calibre, it would correspond very nearly with the French proportions.

As to length, the proportional length of the French gun, that is, its length in calibres, is, like our own six pdr., about 16.

Some of our six pounders have been reamed out to the calibre of 3.80, and then rifled. These of course would be much lighter in proportion to their calibre than the French guns, but if we compare them with the Russian rifled gun as a standard, we will find them to be only 10 lbs. too light, that is, making no allowance for the amount of metal removed by reaming and rifling.

With our American system of expanding projectiles we are not bound, however, to a very exact observance of the proportions of calibres, &c. For example, with what is known as the Schenkl projectile, the same shot is used for both the 3.67 and the 3.80 gun, the sabots only differing in diameter. If the Schenkl system should be adopted, it might be advisable to bring all of our 6 pdr. guns to the calibre of 3.80, and to use different diameters of projectiles for long range shells and for shrapnels. The propriety of doing so can best be determined by experimental firing.

NOTE H, p. 27.—The calibres, &c., of the rifled boat howitzer and of the French rifled cannon are given below.

	Calibre.	Length of bore.	Total length.	Weight.
Dahlgren gun . .	3.40 inches.	55.23 inches.	63.5 inches.	780 lbs.
French gun . . .	3.40 "	55.12 "	62.99 "	727 "

The measurements of the French gun are taken from a table given by Col. d'Herbelot.

NOTE J, p. 27.—It cannot be said that the calibres of rifled cannon have been much governed in Europe by a desire to utilize old material, since various nations, in adopting the rifled system, have changed the material of their field guns from bronze to cast steel, and, as a general thing, their light artillery would seem to be new guns, and not old ones rifled.

NOTE K.—In determining the relative accuracy of fire-arms, it is to be observed that an opinion drawn from a comparison of them at one distance

only is liable to be erroneous, especially if that distance is less than two-thirds of their extreme service range.

This law is especially well illustrated by certain tables of firing with small arms which are given by Lt. de Plœnnies (Nouvelles Etudes sur l'arme à feu rayé). When the relative accuracies of the projectiles are expressed by diagrams, as has been done on page 13, the different lines are seen to approach each other at certain distances, then to recede, sometimes to cross each other, and, finally, to separate widely toward their terminations. Their position near their terminations or at the greatest ranges indicates pretty well, although on a somewhat magnified scale, their average relative accuracy for all distances.

We may infer from this, that where it is not convenient to fire a projectile at a series of ranges, firing at the longest practicable range should be resorted to, and that the results obtained in this manner may be relied upon to a certain extent as expressing its real comparative accuracy. The French artillerists appear to have arrived at a similar conclusion, for what has been published of their practice firing, seems to relate mainly to firing at distances of from 2,000 to 3,500 yards, the projectiles being so fired as to fall on a plain, and the number being counted which strike within a certain rectangle.

NOTE L.—The French rifled field pieces are sometimes spoken of as guns of the La-Hitte system, from the name of General La-Hitte, the President of the artillery board by whom they were brought into service; and sometimes as the Napoleon rifled cannon.

THE undersigned offers to the public—for business abroad—the services of able and accomplished correspondents in London, Paris, and in most of the larger cities of Europe north of the Alps, points through which he reaches readily to Spain, Italy, and Russia.

They bring to the execution of any kind of business whatever, a good faith and moderation which have never been questioned; and a judgment and discretion—when these qualities need to be referred to—always marked by skill, capability, and entire trustworthiness. The undersigned has never relied on them in vain.

Merchandise of any nature imported to order.

FRANCK TAYLOR,

Washington City.